AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1 (original). A method for processing an article comprising a mixed conducting metal oxide material, which method comprises

(a) contacting the article with an oxygen-containing gas and reducing or increasing the temperature of the oxygen-containing gas;

(b) when the temperature of the oxygen-containing gas is reduced, reducing the oxygen activity in the oxygen-containing gas; and

(c) when the temperature of the oxygen-containing gas is increased, increasing the oxygen activity in the oxygen-containing gas.

Claim 2 (original). The method of Claim 1 wherein the article has a stoichiometric composition, the article is cooled, and the oxygen activity in the oxygen-containing gas is reduced while cooling so that the oxygen activity is substantially in chemical equilibrium with the stoichiometric composition of the mixed conducting metal oxide material during at least a portion of the cooling.

Claim 3 (original). The method of Claim 1 wherein the article has a stoichiometric composition, the article is heated, and the oxygen activity in the oxygen-containing gas is increased during heating so that the oxygen activity is substantially in chemical equilibrium with the stoichiometric composition of the mixed conducting metal oxide material during at least a portion of the heating.

Claim 4 (original). The method of Claim 1 wherein the oxygen-containing gas comprises a diluent and wherein the oxygen activity in the oxygen-containing gas is changed by changing concentration of the diluent therein.

Claim 5 (original). The method of Claim 1 wherein the oxygen activity in the oxygen-containing gas is changed by changing the total pressure of the oxygen-containing gas.

Claim 6 (original). The method of Claim 1 wherein the oxygen-containing gas comprises one or more components selected from the group consisting of oxygen, nitrogen, nitric oxide, nitrous oxide, carbon monoxide, carbon dioxide, and water.

Claim 7 (original). The method of Claim 4 wherein the diluent comprises one or more components selected from the group consisting of nitrogen, argon, helium, water, and carbon dioxide.

Claim 8 (original). The method of Claim 4 wherein the oxygen-containing gas comprises dioxygen (O_2) and nitrogen.

Claim 9 (original). A method for processing an article comprising a mixed conducting metal oxide material, which method comprises

(a) contacting the article with an oxygen-containing gas comprising dioxygen (O_2) and reducing or increasing the temperature of the oxygen-containing gas;

(b) when the temperature of the oxygen-containing gas is reduced, reducing the oxygen partial pressure in the oxygen-containing gas; and

(c) when the temperature of the oxygen-containing gas is increased, increasing the oxygen partial pressure in the oxygen-containing gas.

Claim 10 (original). The method of Claim 9 wherein the article has a stoichiometric composition, the article is cooled, and the oxygen partial pressure in the oxygen-containing gas is reduced while cooling so that the oxygen partial pressure is substantially in chemical equilibrium with the stoichiometric composition of the mixed conducting metal oxide material during at least a portion of the cooling.

Claim 11 (original). The method of Claim 9 wherein the article has a stoichiometric composition, the article is heated, and the oxygen partial pressure in the oxygen-containing gas is increased during heating so that the oxygen partial pressure is substantially in chemical equilibrium with the stoichiometric composition of the mixed conducting metal oxide material during at least a portion of the heating.

Claim 12 (original). The method of Claim 9 wherein the oxygen-containing gas comprises a diluent and wherein the oxygen partial pressure in the oxygen-containing gas is changed by changing the concentration of the diluent therein.

Claim 13 (original). The method of Claim 9 wherein the oxygen partial pressure in the oxygen-containing gas is changed by changing the total pressure of the oxygen-containing gas.

Claim 14 (original). The method of Claim 12 wherein the diluent is selected from the group consisting of nitrogen, argon, helium, carbon dioxide, water, and mixtures thereof.

Claim 15 (original). The method of Claim 9 wherein the oxygen-containing gas is a mixture formed by the combustion of an oxidant gas containing dioxygen (O_2) and a fuel and further wherein the oxygen partial pressure in the oxygen-containing gas is changed by changing the relative amounts of the oxidant gas and the fuel prior to combustion.

Claim 16 (original). The method of Claim 15 wherein the oxidant gas is air and the fuel comprises methane.

Claim 17 (original). A method for heating or cooling an article comprising a mixed conducting metal oxide material having a stoichiometric composition, which method comprises

(a) contacting the article with an oxygen-containing gas while changing the temperature of the article; and

(b) at any temperature while changing the temperature of the article, maintaining the oxygen activity in the oxygen-containing gas at a value that is less than the oxygen activity in the oxygen-containing gas that would be in chemical equilibrium with the stoichiometric composition of the mixed conducting metal oxide material in the article at the same temperature.

Claim 18 (original). A method of operating an ion transport membrane system comprising

(a) providing at least one membrane module comprising a membrane made of mixed conducting metal oxide material;

(b) contacting the membrane with a heated oxygen-containing gas comprising dioxygen (O_2) while the temperature of the membrane is reduced or increased;

(c) when the temperature of the membrane is reduced, reducing the oxygen partial pressure in the oxygen-containing gas; and

(d) when the temperature of the membrane is increased, increasing the oxygen partial pressure in the oxygen-containing gas.

Claim 19 (original). The method of Claim 18 wherein the membrane has a stoichiometric composition, the membrane is cooled, and the oxygen partial pressure in the oxygen-containing gas is reduced while cooling the membrane so that the oxygen partial pressure is substantially in chemical equilibrium with the stoichiometric composition of the membrane during at least a portion of the cooling.

Claim 20 (original). The method of Claim 18 wherein the membrane has a stoichiometric composition, the membrane is heated, and the oxygen partial pressure in the oxygen-containing gas is increased while heating the membrane so that the oxygen partial pressure is substantially in chemical equilibrium with the stoichiometric composition of the membrane during at least a portion of the heating.

Claim 21 (original). The method of Claim 18 wherein the oxygen partial pressure in the oxygen-containing gas in contact with the membrane is changed by mixing a diluent gas with the oxygen-containing gas.

Claim 22 (original). The method of Claim 18 wherein the oxygen partial in the oxygen-containing gas in contact with the membrane is changed by changing the total pressure of the oxygen-containing gas.

Claim 23 (original). The method of Claim 18 wherein the heated oxygen-containing gas is provided by the direct combustion of an oxidant gas comprising dioxygen (O_2) with a fuel.

Claim 24 (original). A method of operating an ion transport membrane system comprising

(a) providing two or more membrane modules operating in series, each module comprising a membrane made of mixed conducting metal oxide material;

(b) contacting each membrane with a heated oxygen-containing gas comprising dioxygen (O_2) while reducing the temperature of each membrane or increasing the temperature of each membrane;

(c) when the temperature of each membrane is reduced, reducing the oxygen partial pressure in the oxygen-containing gas in each membrane module such that the oxygen partial pressure in the oxygen-containing gas in one of the membrane modules is different than the oxygen partial pressure in the oxygen-containing gas in another of the membrane modules; and

(d) when the temperature of each membrane is increased, increasing the oxygen partial pressure in the oxygen-containing gas in each membrane module such that the oxygen partial pressure in the oxygen-containing gas in one of the membrane modules is different than the oxygen partial pressure in the oxygen-containing gas in another of the membrane modules.

Claim 25 (original). An ion transport membrane system comprising

(a) at least one membrane module having a membrane comprising mixed conducting metal oxide material;

(b) means for contacting the membrane with a heated oxygen-containing gas and means for reducing or increasing the temperature of the membrane;

(c) means for reducing the oxygen partial pressure in the oxygen-containing gas when the temperature of the membrane is reduced; and

(d) means for increasing the oxygen partial pressure in the oxygen oxygen-containing gas when the temperature of the membrane is increased.

Claim 26 (original). The system of Claim 25 wherein the mixed conducting metal oxide material has the general stoichiometric composition $(Ln_{1-x}A_x)_w(B_{1-y}B'_y)O_{3-\square}$, wherein Ln represents one or more elements selected from La, the D block lanthanides of the IUPAC periodic table, and Y; wherein A represents one or more elements selected from Mg, Ca, Sr and Ba; wherein B and B′ each represent one or more elements selected from Sc, Ti, V, Mn, Fe, Co, Ni, Cu, Cr, Al, Zr and Ga; wherein $0 \leq x \leq 1$, $0 \leq y \leq 1$, and $0.95 < w < 1.05$; and wherein $\square$ is a number that renders the compound charge neutral.

Claim 27 (original). The system of Claim 26 wherein the mixed conducting metal oxide material has the general stoichiometric composition $(La_xCa_{1-x})_w FeO_{3-\delta}$ wherein $1.0 > x > 0.5$, $1.1 \geq w \geq 1.0$, and δ is a number which renders the composition charge neutral.

Claim 28 (original). The system of Claim 27 wherein the mixed conducting metal oxide material has the general stoichiometric composition $(La_xSr_{1-x})_wCoO_{3-\delta}$ wherein $1.0 > x > 0.1$, $1.05 \geq w > 0.95$, and δ is a number which renders the composition charge neutral.

Claim 29 (original). The system of Claim 28 wherein the mixed conducting metal oxide material has the general stoichiometric composition $(La_{0.4}Sr_{0.6})_wCoO_{3-\delta}$ wherein $1.05 \geq w > 0.95$ and δ is a number which renders the composition charge neutral.

Claim 30 (original). The system of Claim 25 which further comprises a combustor for combusting an oxidant gas comprising dioxygen (O_2) with a fuel to generate a combustion product that provides the heated oxygen -containing gas.

Claim 31 (original). The system of Claim 30 which further comprises a fired heater to further heat the heated oxygen-containing gas by indirect heat transfer with hot combustion gases in the fired heater.

Claim 32 (original). A method of operating an ion transport membrane system comprising

(a) providing a membrane module comprising a membrane made of mixed conducting metal oxide material, wherein the membrane has a first side and a second side;

(b) heating or cooling the membrane; and

(c) while heating or cooling the membrane, contacting the first side of the membrane with a first oxygen-containing gas and contacting the second side of the membrane with a second oxygen-containing gas, wherein at any time during the heating or cooling the oxygen activity in the first oxygen-containing gas is different than the oxygen activity in the second oxygen-containing gas.

Claim 33 (original). The method of Claim 32 wherein the first and second oxygen-containing gases each comprise dioxygen (O_2) and wherein at any time during the heating or cooling the oxygen partial pressure in the first oxygen-containing gas is different than the oxygen partial pressure in the second oxygen-containing gas.